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Disease-a-Month

Coronary Atherosclerosis and Its Management

J. WILLIS HURST
ROBERT SCHLANT

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PUBLISHERS' NOTE

The publishers are pleased to announce that Dr. Harry F. Dowling, Professor and Head of the Department of Medicine, University of Illinois College of Medicine, has been appointed Editor of the Disease-a-Month series by the Editorial Board. The appointment is effective immediately. Dr. Nicholas J. Cotsonas of the same institution will assist him in his duties.

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INTRODUCTION

Thumbnail Sketch of Man Least Likely to Have Coronary Heart Disease

An effeminate municipal worker or embalmer,
Completely lacking in physical and mental

alertness and without drive, ambition or
competitive spirit, who has never attempted

to meet a deadline of any kind.
A man with poor appetite, subsisting on fruits

and vegetables laced with corn and whale oil
Detesting tobacco,
Spurning ownership of radio, TV, or motor car
With full head of hair and

Scrawny and unathletic in appearance;
Yet constantly straining his puny muscles
by exercise.
Low in income, blood pressure, blood sugar,
uric acid and cholesterol,
Who has been taking nicotinic acid,
pyridoxine and long term
anti-coagulant therapy
Ever since his prophylactic castration.

THE PRECEDING BLANK VERSE was written by our friend, Dr. Gordon Myers of Boston, Massachusetts (21). It should serve to make the most dour student of medicine take inventory of his concepts of coronary atherosclerosis. The verse tells us several things in a subtle but palatable way. Since the verse deals with prophylaxis, it implies that the disease *coronary atherosclerosis* may be present for many years before symptoms occur. The verse points out that many parameters of the pathologic process are being studied by a large number of investigators. It also hints that we cannot now apply *all* of the results of the investigations to all persons. And it leaves no doubt that there is confusion in the field. Accordingly, in 1960, we must accept the fact that the etiology of coronary atherosclerosis is unknown.

That the disease is being studied—that it is no longer considered to be merely the consequence of aging—is exciting. Answers will come, but they are not at hand now.

Coronary atherosclerosis can be viewed from two vantage points: (1) as viewed by the pathologist and (2) as viewed by the clinician. The pathologist soon learns that the ordinary methods of examining the coronary arteries are not adequate. The load of routine work in the average hospital prevents anything but the routine cut down the coronary arteries with scissors or transverse cuts with a knife through the arteries at very close intervals. Blumgart, Schlesinger and Davis (3) have shown that more can be learned by the injection of the coronary arteries with colored radiopaque agar than by routine methods. Their classic work was a very important contribution to medicine. Their method demonstrates coronary arterial narrowing, occlusions and collateral circulation in a much larger percentage of hearts than had been previously found by ordinary methods of study. Although the correlation between

clinically recognizable coronary atherosclerosis with pathologic findings is fairly good in a large percentage of patients, a major problem does remain. Even when the heart and coronary arteries are examined carefully at autopsy, it is not possible to state from such an examination whether or not the patient exhibited signs and symptoms of coronary atherosclerosis during life. Three examples illustrating this problem in pathology may be given: (1) The coronary arteries of a 50-year-old man may show considerable atherosclerosis at autopsy; yet he may have had no symptoms or signs of disease during life. (2) A young man may develop classic angina pectoris, and even die of a cardiac arrhythmia, and at autopsy only slight coronary atherosclerosis may be discovered. (3) The patient may have died of some other form of heart disease, or even from some noncardiac disease; yet an error could have been made in the latter case if the coronary disease found at autopsy was considered to be the sole etiology of the death. To summarize: We cannot look at a coronary artery alone and determine the extent to which the heart has been deprived of blood or determine how well the heart has functioned during life. An appraisal of the collateral coronary vessels cannot be made even though this is extremely important, for it is the balance between the coronary obliterative process and the development of collateral circulation that determines the degree of heart damage in most cases.

The clinician now knows that many people will have pathologic evidence of atherosclerosis, but he does not make the diagnosis of coronary atherosclerosis merely because he knows this fact. He cannot make a diagnosis of coronary atherosclerosis unless his patient has certain signs and symptoms. The development of these signs and symptoms implies that the long-standing atherosclerosis has finally reached a state that is sufficient to cause recognizable trouble, although the clinician cannot always predict the extent of the pathologic involvement.

This monograph will deal almost exclusively with coronary atherosclerosis as recognized by the clinician.

FACTORS DETERMINING APPEARANCE OF SIGNS AND SYMPTOMS OF CORONARY ATHEROSCLEROSIS

Signs and symptoms of coronary atherosclerosis as recognized by clinicians seem dependent on three variable factors, as follows:

FIG. 1.—Vessel factors determining the clinical features of coronary atherosclerosis. *A*, the obliterative process—the result of atherosclerosis and thrombosis. As the occlusive disease progresses and ischemia occurs, the collateral circulation develops. *B*, the collateral circulation. Although collateral flow may be inadequate without clinical signs and symptoms, it can be surmised that the collateral blood flow is definitely inadequate when certain signs and symptoms are present. The relationship between the obliterative process and the collateral circulation is a major factor determining the degree of myocardial damage and the clinical features of coronary atherosclerosis.

1. The first factor may be called a *vessel factor* (Fig. 1). The atherosclerotic narrowing of the coronary arteries may be called the "obliterative process," a general term including gradual narrowing and occlusions, as well as small and large thromboses of the coronary arteries. While the obliterative process is progressing, it is fortunate that collateral coronary circulation is developing. These important collateral vessels are difficult to study. Evidence is available suggesting that collateral flow may

be inadequate even in the absence of signs and symptoms—before the disease can be diagnosed clinically (24). It can be surmised, however, that collateral flow is definitely inadequate by the time certain signs and symptoms are present.

2. The needs of the myocardium may be called *cardiac muscle factors* (Fig. 2). A thick ventricle, made up of large myocardial fibers, may require more blood and oxygen than does the normal ventricle with normal-size fibers. This means that a patient with valve disease or hypertension may have clinical

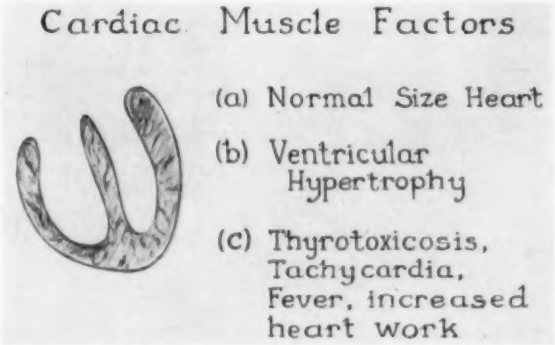

FIG. 2.—Cardiac muscle factors influencing the clinical features of coronary atherosclerosis: (*a*) the normal heart muscle and its work requirements; (*b*) the increased blood flow required by hypertrophied muscle fibers; and (*c*) other muscle factors, such as thyrotoxicosis, tachycardia, fever, increased heart work, etc.

signs and symptoms of cardiac ischemia with less coronary atherosclerosis than would a patient whose heart is otherwise normal except for coronary disease. Normal-size muscle fibers require more blood and oxygen in situations of increased tissue demand, such as occurs with thyrotoxicosis, increased body temperature and persistent tachycardia. The clinician is pleased when he finds thyrotoxicosis in his patient with symptoms and signs of ischemic heart disease, since the management of hypermetabolism may relieve the symptoms related to coronary atherosclerosis.

3. Factors having to do with the blood as it enters the coro-

nary arteries may be called *blood factors* (Fig. 3). Although the blood carries clotting factors which may be abnormal, clotting has been included under vessel factors, since it is probable that an abnormal vessel must be present in addition to the clotting factors in order for blood to clot in the coronary arteries. (*a*) If the blood itself is not of normal quality, as in anemia, this may be a serious contributing or precipitating cause of cardiac ischemia in patients with coronary atherosclerosis. This was dramatized for us by one patient who had

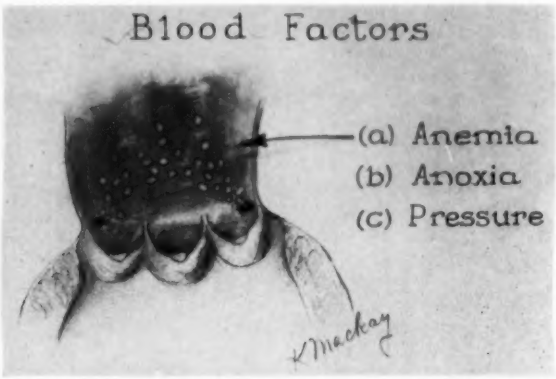

FIG. 3.—Blood factors influencing the clinical features of coronary atherosclerosis: anemia, anoxia, abnormally low blood pressure, etc. These may decrease the amount of oxygen reaching the myocardial cells. (For clotting factors, see Figure 1.)

gastrointestinal bleeding due to inoperable telangiectases. She came to the hospital emergency clinic repeatedly and requested that her stool be checked for blood whenever her angina pectoris increased in frequency. Her appraisal of the situation was usually correct. (*b*) Anoxia is always serious. It is even more serious in patients with coronary atherosclerosis. Anoxia may be due to lung disease, a plugged bronchus, deep anesthesia and high altitudes, among other causes. It must be looked for and eliminated whenever possible, since the patient with coronary atherosclerosis is operating with a narrow margin of safety. (*c*) The blood pressure is an important factor in deter-

mining coronary artery perfusion. Accordingly, patients with coronary atherosclerosis who have hypotension and shock may develop cardiac ischemia, of varying degrees, which might not otherwise have occurred. A patient with aortic stenosis or aortic regurgitation not only has a big ventricle which needs more blood but may have an abnormal blood pressure at the mouth of the coronary artery, in addition to an unknown amount of coronary atherosclerosis.

When these *blood factors* are normal and the only *cardiac muscle factors* are those demanded by stresses that are within physiologic limits, the problem becomes a *vessel problem.* To restate: In the absence of anemia, anoxia, hypotension, ventricular hypertrophy, thyrotoxicosis and tachycardia, the development of signs and symptoms of ischemic heart disease depends on the progression of the obliterative process (in speed and extent) in the coronary arteries, on the one hand, and the development of collateral circulation (in speed and extent), on the other hand. Also to be considered are the requirements of the ventricular muscle as determined by the physiologic demands of exercise, fear, anger and other "normal" requirements of the heart muscle.

To simplify even further, the signs and symptoms due to coronary atherosclerosis occurring in a patient who is otherwise normal can be considered to be the result of the "battle of the vessels." There are two types of vessels involved, and therefore there are two forces to consider. The first force is the obliterative process of coronary atherosclerosis; the second is the collateral circulation. Clinically recognizable coronary atherosclerosis depends, to a great extent, on the balance of these two opposing forces.

The following clinical situations seem to exist:

1. A young man may have no signs or symptoms of ischemic heart disease. The clinician cannot diagnose heart disease in this case even though it is likely that the pathologist would find early evidence of coronary atherosclerosis.

2. A middle-aged man may have no signs or symptoms enabling the physician to diagnose ischemic heart disease. The pathologist may find considerable coronary atherosclerosis. No symptoms or signs have appeared because there has not been sufficient ischemia to produce them. The collateral circulation has apparently been adequate to prevent the development of pain due to ischemia, although myocardial infarction may occasionally be found (24).

3. The physician obtains a history of angina pectoris from a patient. The symptoms have been present from weeks to years and are produced by an expected amount of effort or emotion. The chest discomfort lasts a few minutes, usually 1–10, and is promptly relieved by nitroglycerin. The frequency, duration and intensity of symptoms have not changed. This patient's symptoms can be labeled as stable angina pectoris. The pathologist might see moderate atherosclerosis, major vessel occlusion and areas of fibrosis. When the latter areas are large enough, the term "small infarction" is applicable (25). Here, too, there is a balance between the coronary arterial obliterative process and the collateral circulation, but the balance exists only during the period of mild activity and stable emotions. When the cardiac muscle factors change—when the oxygen requirements of the myocardium increase—as occurs from more than usual effort or when the heart does more work as a result of a strong emotional stimulus, the delicate balance between the obliterative process of the coronary arteries and the collateral circulation no longer exists. In this situation, the collaterals are not adequate to prevent the pain of ischemia when there are added myocardial factors, even if the latter are within physiologic limits.

4. A patient may have angina pectoris of recent origin. The pathologist may find coronary atherosclerosis of varying degree, major vessel occlusion and small areas of myocardial necrosis and fibrosis. This type of angina pectoris should be separated from stable angina. When angina pectoris occurs for the first time in the absence of blood factors and myocardial factors, it can be said that the obliterative process has developed more rapidly than the collateral occlusion. Snow and his collaborators (25) have supplied pathologic studies to support the view that small myocardial infarcts have occurred under such circumstances. As will be pointed out, the management of this type of case is different from that of stable angina.

5. The patient who has had angina pectoris for some time but has noticed a recent increase in symptoms must also be regarded as different from the patient with stable angina. The increase in symptoms may be in the form of increased frequency of angina pectoris with less effort; nocturnal angina; prolonged episodes of pain, especially at rest; or failure of nitroglycerin to relieve the symptoms as easily as formerly. The pathologist may again find moderate to severe coronary atherosclerosis, major vessel occlusion and areas of myocardial necro-

sis and fibrosis. Here, too, it is likely that small myocardial infarctions are occurring. Again, the obliterative process has progressed more rapidly than the collateral circulation. As will be pointed out subsequently, the management of this type of angina pectoris is also different from that of stable angina.

6. The pathophysiology of the patient with intractable angina pectoris or angina decubitus lasting over a period of weeks is not fully understood. Occasionally patients will have repeated bouts of angina pectoris even while at rest for weeks at a time. The pathologist usually finds advanced coronary atherosclerosis, major vessel occlusion and many small to large areas of myocardial necrosis and fibrosis. The relationship between the supply and demand of blood to the myocardial cells may be so delicate that even the body's normal homeostatic mechanisms may be sufficient to throw the relationship out of kilter and ischemia or infarction may occur. Management of this type of case is very difficult, and will be discussed later.

7. A prolonged episode of pain of coronary origin is usually caused by a myocardial infarction. Pain due to coronary disease lasting longer than 30 minutes at rest is probably associated with myocardial cellular necrosis (25). If only a few cells die, other objective evidence may not develop. The electrocardiogram may remain normal, as may the blood pressure, serum enzymes, red blood cell sedimentation rate, temperature and white blood cell count. There are many reasons why these parameters may remain normal. Example: the electrocardiogram may not be diagnostic of myocardial infarction because the infarct is small, because it is located in the part of the heart that did not alter the electrocardiogram, because of other abnormalities in the heart and because repeated tracings were not obtained. One can highlight this problem by asking a question: How many dead myocardial cells must be present in order to have an abnormal electrocardiogram, abnormal serum enzymes, an elevated sedimentation rate, an elevation of temperature or a high white blood cell count? It would seem advisable to consider chest pain of coronary origin lasting 30 minutes or longer as being the result of a myocardial infarction. This conclusion is reached when one considers the following: (*a*) Many patients *without* objective evidence of myocardial necrosis have clinical stories that are similar to patients *with* objective evidence of infarction. Occasionally, definite myocardial infarction is found at autopsy in patients who have had no objective evidence of tissue necrosis. (*b*) It is not unusual to find one

test abnormal and one test normal; for example, the electrocardiogram may remain normal and certain serum enzymes may become elevated. (*c*) The work of Snow and his coworkers (25) in England gives pathologic support to such a concept.

Even if such a concept is not accepted, at least it must be admitted that, when a patient has prolonged chest pain of coronary origin (i.e., myocardial ischemia) and the blood factors and cardiac muscle factors have not changed, there has been a rather sudden increase in the obliterative process (perhaps by thrombosis) and this process has outstripped the collateral circulation. Whether or not objective evidence of myocardial necrosis develops depends on other factors.

The concept of coronary spasm as a cause of symptoms in patients with coronary atherosclerosis is not a good one. This idea has almost vanished from medical thinking, but it is occasionally mentioned. It is noted here in order that it can be kicked once more in public. The terms "coronary insufficiency," "coronary failure" and "intermediate coronary syndrome" have led to confusion. These terms do not mean the same to all people, and they are usually used in circumstances that differ from the situations pointed out by the investigators who first described the conditions. These terms can be discarded, if one thinks in terms of blood factors, vessel factors and cardiac muscle factors.

From the foregoing, the following conclusion may be reached: The signs and symptoms of coronary atherosclerosis depend on the speed and extent of coronary arterial obliterative process, the development of collateral coronary circulation, the blood factors and the cardiac muscle factors. When the blood factors and cardiac muscle factors have been eliminated, the balance between obliterative process and the collateral circulation becomes all important. Whether or not objective evidence of myocardial cell death develops depends on the abruptness and the extent to which the obliterative process has outstripped the collateral circulation. The all-important question to ask one's self regarding patients with coronary atherosclerosis is: Is there clinical evidence, from signs and symptoms, that the obliterative process has outstripped the collateral circulation? If the answer is yes, then the next problem is to quantify the heart damage—the problem is no longer a qualitative one. It follows next that therapy may differ somewhat when the heart

damage is small compared to the situation when the damage is great.

CLINICAL RECOGNITION OF CORONARY ATHEROSCLEROSIS

Having considered the pathophysiologic basis for the appearance of signs and symptoms, one can now consider the clinical evidence—both signs and symptoms—required in order to diagnose coronary atherosclerosis that has become advanced enough to cause recognizable trouble during life. It is not the purpose of this monograph to discuss the details of the clinical features of coronary atherosclerosis; accordingly, these features will be discussed only in a general way.

A clinician can diagnose coronary atherosclerosis under the following conditions:

1. Coronary atherosclerosis can be diagnosed when there is a history of angina pectoris. This is one of the most positive findings substantiating this diagnosis. There are other causes of angina pectoris, such as aortic stenosis, aortic regurgitation, coronary ostial disease due to syphilis, etc.; but in the absence of these diseases, coronary atherosclerosis is highly likely. Even when other diseases are present, coronary atherosclerosis may also be present. The diagnosis of angina pectoris is made solely on the typical history obtained from the patient. Such history taking is truly an art. One must be mindful of other conditions that may simulate angina pectoris, such as anxiety, musculoskeletal pain, pulmonary hypertensive pain and the pain of esophageal and gastrointestinal origin.

The resting electrocardiogram is normal in the majority of cases of angina pectoris. The electrocardiogram after exercise may be of some value, but it can be very misleading and must be utilized with the greatest care and wisdom.

2. Coronary atherosclerosis can be diagnosed when there is a typical history of myocardial infarction. This, too, is a rather conclusive diagnostic finding. Myocardial infarction can be a result of a coronary embolus, especially in patients with endocarditis; but this is a rare condition and seldom a diagnostic problem. It is necessary to consider the possibility of dissecting aneurysm and pericarditis in all cases of chest pain suggesting myocardial infarction, since anticoagulant therapy may harm such patients. It is always harmful to diagnose a condition as myocardial infarction when the latter is not present, even if

therapy for infarction would not be as flagrantly harmful as in the conditions just listed. Accordingly, it is necessary to know the clinical features of many other diseases that can cause chest pain, such as pulmonary embolism, pneumothorax, anxiety and ruptured esophagus, in addition to those cited above.

The electrocardiogram may remain normal in myocardial infarction; it may show nonspecific T wave changes; or it may show diagnostic QRS, S–T, and T abnormalities. The tracings must always be interpreted in the light of the clinical picture if errors are to be minimized.

3. Congestive heart failure may be the result of coronary atherosclerosis in two somewhat different clinical settings. Neither situation allows one to be as certain of the diagnosis of coronary atherosclerosis as when definite angina or myocardial infarction has occurred. However, the sudden development of acute pulmonary edema in an otherwise normal adult suggests myocardial infarction. It is necessary to rule out mitral stenosis and other valvular disease, as well as paroxysmal tachycardia. It may be difficult to eliminate these conditions during pulmonary edema. The patient may not complain of pain when myocardial infarction presents with acute pulmonary edema, since dyspnea is so overwhelming. This might be called a painless infarction, but not a symptomless one. Even in hypertensive patients, it is wise to consider myocardial infarction when the patient has sudden pulmonary edema. This is especially true when the patient's exercise tolerance has been excellent in the recent past. The electrocardiogram, as usual, may or may not reveal diagnostic changes of infarction.

Congestive heart failure may develop gradually in the patients with coronary atherosclerosis who do not give a history of angina pectoris or myocardial infarction. The electrocardiogram may be normal or show nonspecific abnormalities, and the heart is usually moderately enlarged. At autopsy the pathologists find areas of myocardial fibrosis, coronary atherosclerosis and considerable occlusive disease in the terminal branches of the coronary arteries. But the physician should beware of jumping at the diagnosis of coronary atherosclerosis in a patient who has no evidence of this disease except heart failure. Many patients thought to be in this group will reveal a history of angina pectoris or myocardial infarction on careful questioning; others have unrecognized aortic stenosis or other valve diseases, myocarditis or some other diffuse myocardial disease, including so-called "senile heart disease" (7), constrictive peri-

carditis or chronic lung disease. A few patients, however, have heart failure as the only evidence of coronary atherosclerosis.

4. The electrocardiogram is obviously helpful in diagnosing myocardial infarction. As one surveys the general attitude of physicians, it seems likely that many are willing to sell short their history taking in reverence to the electrocardiogram. As stated earlier, angina pectoris is usually associated with a normal resting electrocardiogram. The tracing may not reveal diagnostic changes after myocardial infarction. On the other hand, it may reveal a strong clue leading to the diagnosis of coronary atherosclerosis in a patient with a confusing history. Occasionally the electrocardiogram may show diagnostic changes of infarction when the patient has had no pain or symptoms. It may show signs of an infarction that has occurred during a period when the patient was not able to recognize symptoms, such as with diabetic acidosis or during anesthesia. In addition to the more diagnostic QRS, S–T and T changes, there are other electrocardiographic abnormalities that may be a clue to the diagnosis of coronary atherosclerosis, but they are far less specific. Right bundle branch block can be caused by many diseases and may occur in an apparently normal person. It may be a valuable clue when all other causes of right bundle branch block have been excluded, when it has not been present earlier and when it fits with the remainder of the clinical picture. Left bundle branch block is perhaps more often associated with coronary atherosclerosis than is right bundle branch block. There are other causes of this form of bundle block, including myocarditis or other diffuse myocardial disease, severe valve disease and hypertension. Findings of atrial tachycardia and atrial fibrillation are not specific enough to allow one to make a diagnosis of coronary atherosclerosis on these findings alone. Atrioventricular block, especially complete heart block, is suggestive of coronary atherosclerosis if one can exclude congenital heart block, block due to drugs, myocarditis due to diphtheria and rheumatic fever, diffuse cardiac muscle disease, and severe valve disease, especially aortic stenosis. On a statistical basis, however, complete heart block is more often due to coronary atherosclerosis than to the other causes. Even in patients with aortic stenosis, coronary atherosclerosis is frequently present when complete heart block is present. When periods of ventricular fibrillation or standstill interrupt atrioventricular block, the condition is called Stokes-Adams disease. Patients with such disease usually have coronary atherosclerosis. Ventricular

tachycardia may occur in myocarditis, drug intoxication, and perhaps on rare occasion in normal people, but it occurs most often in patients with coronary atherosclerosis.

5. There are several radiographic signs of coronary atherosclerosis. Calcified coronary arteries are occasionally seen, but this finding does not indicate whether or not the process is causing signs and symptoms of this disease. A ventricular aneurysm, secondary to myocardial infarction, may be seen on the x-ray of the chest or at cardiac fluoroscopy. On rare occasions, calcification may be seen in the area of an old myocardial infarction. Visualization of the coronary arteries with contrast media is being investigated.

The clinician does not diagnose coronary atherosclerosis simply because he knows that it is commonly found by the pathologist. He diagnoses coronary atherosclerosis when certain signs and symptoms are present. These include: angina pectoris; myocardial infarction; electrocardiographic and radiologic abnormalities; less frequently, certain cardiac arrhythmias; and, on rare occasions, congestive heart failure.

MANAGEMENT OF CORONARY ATHEROSCLEROSIS

The physician's approach to the patient with coronary atherosclerosis is different today from what it was 20 years ago. In the past, a patient was frequently advised to retire from work, was placed at bed rest for 4 or more months and was told very little about the disease that had caused a marked change in his life. This approach, which often led to the disability of the patient, was based on the limited knowledge of the day. Fortunately, we now have much more information on the subject. The physician caring for the patient has the responsibility of teaching him about his disease. If this is done properly and sensibly, it may be the most helpful therapeutic tool that the physician possesses. It is far better for the physician to take the lead in this matter, since most patients will deduce that they have "heart trouble" and will shelter unnecessary worries and fears. Also, they will obtain information somewhere, much of which will be from the daily newspaper, a weekly magazine or the next-door neighbor.

Since the doctor is to teach his patient, it is desirable that he use a few simple teaching aids. For this purpose a blackboard in the office is useful. The heart and coronary arteries can be

drawn with a display of more genuine personal interest than can be obtained by simply giving the patient written material on the subject. A crude drawing of the anatomy on a sheet of paper is equally good; a heart model is also valuable. The pathophysiology of the disease should be described. Each physician develops his own method of explaining the problem with the use of analogies, drawings and properly selected literature. The material can be presented with an honest and optimistic point of view, since we now have statistics indicating that many patients live for many years (1) after the onset of angina pectoris and that the chance of surviving an uncomplicated acute myocardial infarction is about 80–90%.

The education of the patient with angina pectoris usually begins as soon as the diagnosis is made. The instruction of the patient with a severe myocardial infarction should not be very detailed in the beginning. Soon after an uncomplicated myocardial infarction, it is usually wise to state clearly that the patient had had a heart attack but that his chances of recovery are quite good. This should be followed promptly by a general outline of how long the patient will remain in the hospital. Strong emphasis should be given to the fact that after 2–3 months he will return to work. Obviously, the physician's advice should be tempered by the severity of the attack, although basically an optimistic attitude should prevail. As days go by, the patient's questions should be answered. Before the patient leaves the hospital, he should be taught, in a nonfatiguing manner, what coronary atherosclerosis is and what has happened to him. While the patient is in the hospital, the doctor has the opportunity to relieve fear, decrease anxiety and create a healthy environment for the patient and his family. For example, when sighing respiration is noted, it should be explained to the patient. When the pain of pericarditis or the sticks and stabs of anxiety are felt by the patient, these can be explained. Without such explanations the sick patient assumes that all his symptoms are related to heart disease.

Many things should be discussed with both the patient and the members of his family. These include: the pathophysiology of the disease; the effect of effort and anxiety on the symptoms; the use of nitroglycerin; the use of alcohol and tobacco; sexual intercourse; business worries; marital problems; and the current views about diet. The patient must be taught to notify his physician if there is any increase in pain or change in the nature of the pain. Many of these problems should be antici-

pated and discussed without waiting for the patient to ask, since he may be reluctant or embarrassed to do so.

The proper education of the patient, the maintenance of the optimistic view on the part of the physician, and strong efforts at rehabilitation are among the most important advances that have occurred in this field. These points have been emphasized here because, with other, more dramatic advances being made, one must not lose sight of them.

Activity and Rest

There are two types of rest to consider: mental rest and physical rest. Rest for one person may not be rest for another. This is an individual problem. The better the physician knows the patient, the better he can advise him.

The patient who has a history of relatively stable angina pectoris for several months or more duration may know what physical or emotional factors are likely to precipitate pain and may have learned to avoid these situations. If he has not learned this, he must be taught to live within the limit of physical activity that does not produce pain. For example, a patient who experiences angina after walking 3 blocks may be told to stop after 2 blocks—*before* the pain appears—for several minutes rest before going on. The patients should be encouraged to continue their occupation unless this involves unavoidable heavy strenuous work, which frequently precipitates pain. Particularly unfavorable are exertions to which the patient is unaccustomed: grass mowing and week-end or holiday sports such as swimming, baseball or excessive golf. Often these may be enjoyed, but the patient should slowly build up his tolerance and not suddenly try to do what he has not done in several years. A word of caution should also be given to those contemplating journeys to high altitudes, which would lower the arterial oxygen tension. On the other hand, air travel for one accustomed to flying should carry no undue concern in pressurized cabins. Prolonged exposure to extreme cold or hot temperatures, whether due to a snowstorm, a steam bath or an August heat wave, should be minimized.

Despite the above admonitions, it is felt that controlled, regular physical activity is generally beneficial to the patient with stable angina pectoris. He should be advised that it is better for his heart if he takes an evening stroll leisurely for ½ or 1

hour than if he sits for the whole evening in front of a television screen. There is considerable difference between controlled leisure physical activity and rushing to meet a deadline or catch a subway. Practically all hobbies are to be encouraged, both as a form of mild physical activity and as emotional rest. Much of the specific activity will depend upon what the patient is accustomed to. If, for example, a patient is used to playing golf and finds this does not produce pain, it should be continued. It is not felt advisable to continue physical activity to the point of intentionally producing pain, with the hope that this will further stimulate the growth of collateral coronary circulation. Attempts should be made to find other factors producing unrest, whether it be noisy neighborhood children, certain television programs, or an uncongenial wife, mother-in-law or superior at work.

Angina pectoris that has occurred for the first time implies that the collateral circulation has fallen far behind the obliterative process. In such situations a period of rest is indicated for the collateral circulation to increase. It is recommended that this group of patients be prescribed a program of moderate physical and emotional rest for approximately 3–4 weeks. Some can be managed satisfactorily at home, while others require hospitalization. In the usual situation, the patient may sit in a comfortable chair, go to the table for meals and go to the bathroom. Sedentary activities such as reading and writing and light sitting hobby work should be encouraged. Television and card playing—if the patient's wife gives assurance this is a peaceful repast for the patient—may properly be indulged. Oftentimes in this situation it is of considerable reassurance to the patient and family to be told that these measures are important to *prevent* further damage while waiting for the collaterals to develop.

The patient who has had relatively stable angina pectoris and who then presents with a marked increase in the frequency, duration or severity of attacks is treated similarly to the patient with the initial attack of angina pectoris, and for the same reasons. When angina decubitus has developed, rather complete rest may be required for a variable length of time.

It is usually best to hospitalize patients with acute myocardial infarction. The traditional form of treatment in the hospital has been complete rest in bed; however, in the last few years this has been altered on the basis of both clinical and physiologic observations. Of particular significance has been an

increasing realization of the detrimental effects of prolonged complete immobility in bed. For most patients, these effects can safely be avoided by having the patient in a lounge chair as much as possible (17). There are some patients, however, for whom there are definite contraindications to the chair position: shock or moderate hypotension, evidence of cerebrovascular insufficiency before or after being placed in the chair, marked debility and inadequate personnel or facilities. Under such circumstances, the patient should be managed in bed, with special care being taken to avoid the complications of bed rest.

In most instances, the patient, whether treated solely in bed or with the chair position, is allowed to feed himself the next day or so following the attack. He is instructed to flex his ankles for about 1 minute once an hour and to elevate and rotate his upper arms several times a day. These maneuvers seem to help prevent thrombophlebitis and the shoulder-arm syndrome. It is generally preferable and safer to use a bedside commode or a bedpan on a chair rather than the bedpan in bed. To accomplish this, the patient is assisted with support on both sides. Using a bedside commode is also preferable to bladder catheterization, which may be required when the patient has received morphine. At times it is necessary for male patients to stand with support to initiate voiding.

If there are no contraindications and if a large comfortable chair with a footstool and adequate male personnel is available, the patient is placed in a chair on the first or second day after an infarction. If there have been contraindications initially, the chair position may be tried several days later. To place the patient in the chair, he is first helped to sit up in bed and then allowed to dangle his legs over the side of the bed. Then, with strong support on both sides, he is lifted or supported as he takes a step into the chair. The patient is returned to bed with the same support when he feels too tired to sit up any longer. Usually this is a few hours the first day in the chair and progressively longer each day. The general aim is to have the patient in the chair as much of the day as he is comfortable.

The advantages of the chair position are: (1) greater rest for the heart because of the decreased work resulting from a lower cardiac output due to a decreased venous return in the upright position; (2) decreased tendency for fluid to accumulate in the pulmonary circuit, which might cause pulmonary edema; (3) decreased frequency of hypostatic pneumonia, atelectasis, thrombophlebitis, constipation, etc.; (4) greater

comfort for the patient and (5) marked improvement in the morale, sense of well-being and attitude toward returning to work, with fewer cardiac neuroses. In addition, the marked muscle weakness and postural hypotension which may occur after prolonged periods of bed rest are less likely to develop. The danger of the chair position is that the physician, the nurses, the family or the patient will fail to realize that this is a change of position but not a change of activity. It is definitely not early ambulation. The patient should be as quiet in the chair as in bed.

According to the available studies, it usually takes from 4 to 6 weeks for healing and scar formation to be complete (19). The following program has gradually evolved which seems to allow a reasonable time for myocardial recovery:

In general, the patient with an uncomplicated myocardial infarction should remain in the hospital approximately 3 weeks. When complications have occurred, a longer period may be needed. During the last few days of hospitalization, the patient may be allowed to go to the bathroom with help. At home he should be able to walk to the bathroom. He can usually be allowed to go to a nearby table for meals. Four to 6 weeks after myocardial infarction, he can usually be allowed the freedom of the house. After 6 weeks, he can walk outside on warm days and can go for pleasant rides in an automobile. Between 6 and 12 weeks after the infarction the activity is gradually increased. The patient can usually return to work on a half-time basis in 3 months. As he adjusts to the situation mentally and physically, his work can be increased to full time. It is to be emphasized that the guide to the increase in activity is how the patient responds, and not the electrocardiogram.

Some patients, and many wives, may profit from an activity prescription—that is, a written daily schedule of activity which describes what the patient is to do. Fortunately, many patients, such as executives, may be allowed to do more following recovery from a myocardial infarction than they were doing before the attack. Most patients can do as much, while a small group must do less.

Relief of Pain and Anxiety

No drug has proved to be more effective for the relief of angina pectoris than has old-fashioned nitroglycerin. Amyl ni-

trate is effective, but it is usually no better than nitroglycerin and is much more bothersome to use. Unfortunately, nitroglycerin is not always used properly. The use of the drug must be discussed in detail with the patient. He must be reassured that it is not habit forming and not dangerous when used properly; also, that it will not "blow them up." Anxious members of patients' families should be taught that, when nitroglycerin is used by the patient, it does not necessarily indicate that a "heart attack" is occurring. The tablets of nitroglycerin must be fresh. Pain makes for more pain. Accordingly, the tablet of nitroglycerin should be placed under the tongue as soon as the chest discomfort is felt. Many patients use 0.65 mg. (1/100 gr.) nitroglycerin. This is usually too much, and the unpleasant headache that results may be worse than the chest discomfort. The object is to use the least amount of nitroglycerin in order to obtain relief. Many times, 0.32 mg. (1/200 gr.), or even 0.16 mg. (1/400 gr.), is adequate. Side effects include headaches, dizziness, faintness and syncope. The patient should sit or lie down when trying nitroglycerin for the first few times, while he is determining his individual requirement of the drug. Occasionally, nitroglycerin may make angina pectoris worse. Presumably this occurs because the effects on the peripheral circulation, with resulting arterial hypotension and venous pooling, may be more pronounced than the effect of the nitroglycerin on the heart. There is still no agreement regarding the mechanism of action of nitroglycerin on the heart. Most investigators believe that the drug increases coronary blood flow. When one tablet does not relieve a patient's chest pain as it formerly has, it is unlikely that several more tablets will be helpful. In fact, the suggestion that the patient take a tablet of nitroglycerin every 5 minutes until relief is obtained may be harmful. Not only may hypotension be produced; but, in addition and just as important, this suggestion indicates a lack of understanding that such prolonged pain, unresponsive to nitroglycerin, usually represents myocardial infarction.

Nitroglycerin should be used before any activity that is known to produce discomfort. When the patient has postprandial angina, it is particularly valuable to suggest the use of nitroglycerin before a meal. The drug can also be used before sexual intercourse, mild activity and tense business meetings. It should not be used in a prophylactic way in order to attempt more than is reasonable. For example, a tablet of nitroglycerin,

of itself, is not ample protection against a fierce argument or unusual exercise.

Nitroglycerin should not be used for the relief of the discomfort associated with myocardial infarction. As stated, several tablets may cause hypotension and, in addition, may delay the administration of the proper drug, which is an opiate. Even when short episodes of angina pectoris follow in the wake of a myocardial infarction, and even when a private nurse is with the patient, it seems that the use of nitroglycerin too often delays the administration of an opiate. There are obvious exceptions to this, and every situation must be assessed individually. In general, however, anything that delays the administration of an opiate when it is highly likely to be needed is not recommended.

Numerous long-acting drugs have been used in an attempt to prevent angina pectoris or to decrease the number of attacks. Some are nitrites; others are not. Pounds of such materials are available—and even used. Two per cent nitroglycerin ointment may be helpful. One-half to 1 inch of ointment is applied to the skin two to three times daily. Withdrawal symptoms may occur if the drug is stopped suddenly. A form of nitroglycerin that is released slowly, known as Nitroglyn, is available for oral use. The dose is 2.6–6.5 mg. (1/25–1/10 gr.) two to three times daily by mouth. Such long-acting nitroglycerin preparations are commonly used for angina decubitus. Pentaerythritol tetranitrate (Peritrate) can be given in 10 mg. doses before meals and at bedtime. This drug is one of the most popular drugs used for long-acting effect. No one who carefully reviews the available literature and works with patients with angina pectoris can be enthusiastic about any of the available drugs except nitroglycerin. These include: other nitrites, the xanthines, papaverine, Ammi visnaga, monamine oxidase inhibitors, vitamin E, nicotinic acid, etc. Nitroglycerin remains the cheapest and the best drug available for the management of angina pectoris. When it is used properly, it works like magic.

When nitroglycerin does not relieve the discomfort of angina pectoris, an opiate is usually indicated. In general, opiates are used to relieve the discomfort of myocardial infarction, and nitroglycerin is not tried when an infarction is diagnosed. It is worth while to ascertain from the patient if he has ever been given an opiate in the past and if it was tolerated without difficulty. If he has never been given an opiate, or has tolerated morphine without trouble, morphine sulfate is the drug of

choice. When pain is mild to moderate in severity, 10–15 mg. morphine sulfate should be given subcutaneously and repeated in 30–45 minutes if necessary. If pain is severe, or when there is hypotension sufficient to decrease uptake from a subcutaneous site, it is advisable to give the morphine intravenously. Ten to 15 mg. of the drug should be diluted in 10 ml. saline and given very slowly intravenously. It can be repeated, with caution, if needed. When morphine is given intravenously, it is wise to have nalorphine hydrochloride (Nalline) or levallorphan tartrate (Lorfan) immediately available to counteract the respiratory depression that may develop.

Meperidine (Demerol) may be used in place of morphine. When this drug is given orally, it is not usually very effective for the pain of myocardial infarction. The usual dosage is 75–100 mg. subcutaneously or cautiously by vein. This drug does not relieve pain, or decrease anxiety, to the same degree as does morphine, but it is perhaps less likely to cause nausea and bronchial spasm.

All opiates, including meperidine, decrease respiration both in frequency and magnitude. This must be kept in mind when the patient has pulmonary emphysema or some other disease that has compromised pulmonary function. Severe pain in an emphysematous patient is very perplexing. It forces one to compromise between pain relief and anoxia.

During the first 24–48 hours after a myocardial infarction it is frequently helpful to give an opiate every 4–6 hours. A period of time is required for everyone to adjust to the new situation. During this period the patient has many frustrating experiences. He may not obtain relief from pain even when adequate orders have been written and when adequate trained personnel are available. Obviously, respiratory depression and opiate addiction must be avoided if this technic is employed. Should the patient be a physician or other medical personnel with a myocardial infarction, it is extremely important to give specific orders for opiates, as well as other medication, every 4 hours for a day or so, rather than allow the patient to "ask for it" if needed. Some patients, especially doctors and nurses, will reject the disease and the addicting drugs.

A sedative such as phenobarbital (15–30 mg. three times a day) may be given to patients with angina pectoris and for a while after myocardial infarction. Obviously, all patients do not need drugs for sedation. The newer tranquilizers have not proved to be much of an advance for this purpose, although

they are currently widely used. A short-acting barbiturate should be used at night for sleep after a myocardial infarction and may occasionally be needed for patients with angina pectoris who have trouble sleeping.

Alcohol in various forms and reasonable dosage can be helpful. Of course, it may not be helpful in patients who are bitterly opposed to even the medicinal use of this drug.

When the patient no longer has angina pectoris or has recovered from his myocardial infarction, the long-acting and short-acting sedatives should be eliminated, and the patient should be treated as much like a normal person as possible. All too often, heavy sedation is continued for years after the patient has been completely rehabilitated.

Although atropine sulfate increases the coronary blood flow in animals (10), there is no good evidence for its routine use in myocardial infarction. There are specific times when an atropine effect is desired. For example, myocardial infarction itself can cause sinus bradycardia, nodal rhythm and various degrees of atrioventricular block. Under such circumstances, morphine may even enhance the influences of the vagus nerve and aggravate such rhythms. Atropine may then be indicated in an effort to decrease the effect of the vagus. In fact, in the presence of these cardiac rhythms, meperidine may be preferable to morphine because of its atropine-like action. On the other hand, when there is sinus tachycardia, atrial fibrillation and especially atrial flutter, atropine and meperidine are not desirable drugs to use, since they may increase the ventricular rate. It seems wise, then, to judge the need for an atropine-like drug on an evaluation of the rest of the clinical picture.

Oxygen

The usual uncomplicated myocardial infarction does not require oxygen. Oxygen should be employed whenever there is cyanosis following an acute myocardial infarction. Since it is so difficult to estimate slight degrees of arterial oxygen unsaturation clinically, and even more difficult in the middle of the night under the usual hospital lighting, if there is any question of cyanosis it is probably better to err on the side of being overgenerous with oxygen. If there is shock, marked dyspnea or marked pulmonary congestion, even without apparent cyanosis, oxygen should be administered. In occasional circumstances,

pain following an infarction which has been difficult to relieve with opiates has apparently lessened or disappeared with the administration of oxygen.

A nasal catheter is the most satisfactory method of administering oxygen; the rate of administration should be 5–10 L./minute, using the higher flows for patients with deep inspirations, who may get a higher oxygen concentration from the upper respiratory passages only during the first fraction of their deep inspiration. One should not forget to check the upper abdomen for tympany indicating that the oxygen has been swallowed. Gastric dilatation can be harmful. In severe situations, a face mask and breathing bag for the administration of 100% oxygen should be used without delay. Oxygen tents are used mainly when the patient is unable to tolerate one of the other methods. The tent is usually a rather inefficient method of administering oxygen, although in hot weather this technic will keep the patients relatively cool if no other means are available.

Care should always be taken in administering oxygen to patients with chronic pulmonary disease who might be subject to CO_2 narcosis. Although an elevated arterial pCO_2 and CO_2-combining power with decreased arterial oxygen saturation will usually be found in patients likely to have this condition, there is no good way to predict from these determinations which patients will develop the full-blown syndrome. In such situations, oxygen should be started early at a slow rate. While the patient is continually observed by the physician, the rate of administration may be slowly increased. The object is to relieve anoxia without developing CO_2 narcosis.

The treatment of acute pulmonary edema complicating an acute infarction is often improved by oxygen administered extremely cautiously with a positive pressure apparatus.

Shock

A modest and temporary decrease in blood pressure following myocardial infarction requires no treatment if the patient is otherwise doing well. When he is doing well, it is better not to pester him by having the nurses record the blood pressure every 15 minutes, as is so often done. In such circumstances, rest is considerably more important; and occasional measure-

ments by a physician—not a nurse—are of much greater value than a beautiful chart.

It is important to distinguish between the finding of hypotension and the clinical picture of shock. Either of these may occur without the other, or they may be present together. The best guide to treatment is the appearance and reaction of the patient—not a blood pressure cuff! The level of blood pressure at which symptoms and signs of shock appear varies considerably but seems to be related to the level of blood pressure existing before the infarction. Thus the clinical picture—cold, clammy, sweating skin; decreased urinary output; and possible symptoms of cerebral or myocardial ischemia—may develop at a systolic level of 120 mm. Hg. in some patients with preexisting marked hypertension, while previously normotensive patients may tolerate a systolic level down to 85–90 mm. Hg with no symptoms or signs of shock. Rarely a patient will be perfectly comfortable, with no evidence of shock, with a blood pressure down to 80 mm. Hg systolic. This situation may require only extremely careful observation, although with a blood pressure below 80 mm. Hg systolic it is better to give treatment even when there are no symptoms or signs of shock.

Other factors extremely important in the treatment of shock are: the use of the head-down position with 8–12-inch blocks under the foot of the bed unless there is marked pulmonary congestion; oxygen administration; complete relief of any pain with morphine (keeping in mind the hypotensive effects of such a drug, as well as the nausea it may produce); and an adequate record of urinary output, recognizing that a considerable amount of fluid may be lost by sweating. If there is congestive failure, rapid-acting digitalis preparation should be given slowly by vein; this will frequently improve cardiac function, particularly in patients with elevated venous pressure, and raise the blood pressure even when there is not marked evidence of pulmonary congestion. There is evidence suggesting that all patients with shock following myocardial infarction should receive digitalis when there are no contraindications (11).

When these simple measures fail to relieve shock or severe hypotension, pressor amines are indicated (23). Initially, the use of metaraminol bitartrate (Aramine) is recommended; this drug may be administered either intramuscularly or as an intravenous drip (50–200 mg. in 1,000 ml. 5% dextrose in water). The rate of administration and the concentration used depends on the response of the patient. The danger of excess

fluid administration must be kept in mind. Phenylephrine (Neo-synephrine) may be given either intramuscularly or subcutaneously (5–10 mg.) in very mild cases. It is better given diluted 50–100 mg. in 1 L. of 5% dextrose in water, intravenously as a very slow drip. Mephentermine (Wyamine), hyproxyamphetamine (Paredrine) and methoxamine (Vasoxyl) have also been used. Epinephrine and ephedrine have been abandoned in the treatment of the usual case of shock.

If the foregoing measures, including the use of either metaraminol or phenylephrine, do not succeed in relieving the symptoms and signs of shock, including an adequate urinary output, the prompt use of norepinephrine or levarterenol (Levophed) is recommended. This must be given by slow intravenous drip. Usually a solution of 4, 8, 12, or 16 mg./L. of 5% dextrose in water is used. The blood pressure response to levarterenol must be carefully watched. When the rate of infusion is too slow, the blood pressure may plummet. When the rate of infusion is too fast, the blood pressure may reach dangerously high levels. The major disadvantage is the intense local venospasm produced and possible local tissue sloughs, particularly if the needle should come out of the vein. Fortunately, phentolamine (Regitine) infiltration of the site of accidental subcutaneous infiltration markedly lessens the severity of the tissue reaction.

If there is persistent shock despite the above measures, the addition of hydrocortisone to the intravenous fluid is worth trying. Occasionally this will apparently improve the responsiveness to levarterenol, although too often the patient dies despite its use.

The use of transfusions of 200–300 ml. of plasma when there is hemoconcentration, or whole blood when there is anemia, has been recommended, particularly where the venous pressure is low. The conflicting evidence of their value and the dangers of administering too much fluid and producing pulmonary edema have limited their usefulness. However, if there is marked anemia, the very slow infusion of packed red blood cells is often of great benefit. Whenever these substances are used in this situation, repeated measurements of venous pressure should be made and the physician should be prepared to stop the procedure or even to perform a phlebotomy if the venous pressure rises precipitously or if the patient develops new or increasing evidence of pulmonary edema. Intra-arterial transfusion for this type of shock has not stood the test of time and is not ordinarily recommended.

While shock following a myocardial infarction is usually due to myocardial factors combined with an imbalance between blood volume and the capacity of the vascular bed, other causes should also be considered, such as cerebral or brain-stem vascular insufficiency; arrhythmias, especially ventricular tachycardia; occult bleeding which may have precipitated the infarction and which may then be worsened by anticoagulants; rupture of the heart, ventricular septum or papillary muscle; apparent shock due to arterial embolism or thrombosis in a brachial artery used to measure the blood pressure; and acute hemorrhagic pericarditis and tamponade possibly related to anticoagulant therapy.

Anticoagulants

Anticoagulants appear to decrease the mortality and incidence of complications following acute myocardial infarction (27). There are potential errors in extending statistical studies to an individual patient, and it is not a sin to withhold anticoagulants in patients with simple, uncomplicated myocardial infarction. However, because of the unpredictability of this condition, it is generally recommended that all patients with myocardial infarction be given anticoagulants. It is imperative that one exclude pericarditis, dissecting aneurysm, postmyocardial infarction syndrome and peptic ulcer as a cause of chest pain before administering anticoagulants. Other contraindications include: an inadequate laboratory, other potential bleeding sites or conditions, severe liver disease and possibly severe uremia.

Numerous oral anticoagulants are available. Each physician has his favorite drug. Bishydroxycoumarin (Dicumarol) was the first of the coumarin series to be synthesized. The initial dose is 300 mg. On the second day, 200 mg. is usually administered, or somewhat less for elderly debilitated patients. On the third day and thereafter, dosage is guided by the daily prothrombin time. After 10 days, the interval between prothrombin determinations may be increased to every other day; and by 3 weeks, to every fourth day. The therapeutic range will vary from one laboratory to another. It may be expressed as 2–2½ times normal, 24–38 seconds or 10–30% normal. Twenty per cent of the normal value is usually satisfactory. The usual daily requirement is 50–75 mg., although this may vary from 25 to 175 mg.

Warfarin sodium (Coumadin) may be given in an initial oral dose of 50–75 mg. The effect is noted within 12–24 hours. As a

rule, the dose can be omitted the second day. The usual maintenance dose, which begins the third day, is 2.5–7.5 mg. The advantages of warfarin are: it has a faster action, there is a more rapid recovery time, and it is available for intravenous use.

Biscoumacetate (Tromexan), phenindione (Hedulin) and other anticoagulants are available. No simple product can yet be said to be ideal, despite the ever-increasing claims of the manufacturers, who are busy making more and more variations on the molecule.

The statistical evidence does not prove conclusively that heparin will more favorably improve the course of patients following an acute myocardial infarction than will oral anticoagulants. At present, some physicians use it exclusively, and some not at all; others use it only during the initial period while waiting for the oral anticoagulant to take effect. Since the data are especially weak in regard to this latter practice, heparin is not routinely employed. However, when there is definite evidence of pulmonary embolism, patients are placed on heparin anticoagulation in preference to oral anticoagulation.

Concentrated sodium heparin may be used. The usual dose is 50 mg. deep subcutaneously every 6 hours. The initial dose may be given intravenously. On the first day or two of treatment, a Lee-White clotting time 2 hours after injection is determined to be sure of obtaining a satisfactory level of 25–40 minutes. Patients whose 2-hour clotting time is inadequate, those with definite major pulmonary embolism or those with definite extensive ileofemoral thromboses are given 60–75 mg. every 6 hours. A 5-hour postinjection clotting time is measured to protect the patient against an accumulative effect. This latter determination is usually necessary only once a day. If the clotting time is more than 20 minutes at 5 hours, the next dose is omitted or reduced.

The use of long-term anticoagulation to prevent subsequent myocardial infarctions has been well summarized by Seaman (22):

> Although few physicians now deny that continuous long-term anticoagulation is feasible, some still question its desirability. This is not surprising in view of the controversy still attendant upon the usefulness of anticoagulants in the treatment of acute myocardial infarction. The protagonists point to the strikingly reduced incidence of thromboembolic complications and remarkable increases in survival rates. Certainly much time must elapse, and experiments carefully designed to exclude bias must be completed, before an unequivocal answer can be given as to the desirability of long-term continuous anticoagulant therapy for coronary artery disease.

While the final answer is awaited regarding the benefits of long-term anticoagulants for recognizable coronary atherosclerosis, there appears to be a definite trend toward their use.

Cardiac Arrhythmias

Patients with angina pectoris, and especially patients with myocardial infarction, may develop abnormalities of cardiac rhythm; these disorders of rhythm may be innocuous, may be serious and may result in death. Because of this, quinidine sulfate and procaine amide (Pronestyl) have been routinely used in myocardial infarction by some physicians to prevent these abnormalities. Little proof is available to show that this form of therapy is of value. There are two reasons why it might be harmful: (1) We now know that about two thirds of the patients who die of a cardiac arrhythmia associated with myocardial infarction have cardiac standstill, while only one third have ventricular fibrillation (14). Quinidine sulfate and procaine amide would not be of value in the prevention of cardiac standstill. (2) Some patients, especially with posterior myocardial infarction, develop atrioventricular block. Quinidine sulfate and procaine amide may be harmful to patients with atrioventricular block. For these reasons, these antiarrhythmic drugs are not routinely used in patients with normal heart rhythm following myocardial infarction.

It has recently been emphasized by Corday and his collaborators (6) that many cardiac arrhythmias related to myocardial infarction may disappear following therapy for hypotension.

Ectopic cardiac contractions must be considered to be more potentially dangerous in patients with myocardial infarction than in normal subjects. One or two ectopic beats occurring every 2 or 3 minutes may not require therapy. Two or more ectopic beats every minute should be treated after a rhythm strip has been obtained with the electrocardiograph. Atrial ectopic beats may be the forerunner of atrial fibrillation. Both quinidine and digitalis are effective in their treatment. Therapy is definitely indicated for ventricular ectopic beats when they are multiple, when they are multifocal, when several occur in a row or when they come "out of a T wave." These findings may be the forerunner of ventricular tachycardia or ventricular fibrillation. Quinidine sulfate, 0.2 Gm., may be given orally every 4 hours. Procaine amide, 0.25–0.5 Gm., may be given orally every 4 hours.

Occasionally, ventricular ectopic beats may disappear following therapy with digitalis administered for a failing heart.

Next to ectopic beats, atrial fibrillation is the most common arrhythmia developing after myocardial infarction. As with other uncontrolled rapid rhythms, it may aggravate cardiogenic shock and heart failure. The drug of choice for atrial fibrillation is digitalis. When the clinical situation indicates a degree of urgency, this drug should be used cautiously intravenously. Digoxin (lanoxin), 0.75 mg., should be diluted with 5 ml. saline and given slowly intravenously; 0.5 mg. can be given in 2–4 hours if the rate is still uncontrolled; additional digoxin may still be needed. The dosage of digitalis, as always, depends on the therapeutic response or the development of toxic symptoms; the titration of this drug must be determined for each individual patient. When the situation is not urgent, 1.0 mg. digoxin may be given orally, followed by 0.25–0.5 mg. every 2–4 hours for one or more doses. The average maintenance dose of digoxin is 0.25–0.5 mg. daily. The atrial fibrillation may revert to normal sinus rhythm without further therapy. If atrial fibrillation continues for several days after the rate has been controlled by digitalis, then 0.2–0.4 Gm. quinidine sulfate may be given orally every 2 hours for four or five doses in an effort to revert the rhythm to normal.

Atrial tachycardia is treated with digoxin, as described above, under atrial fibrillation, when the patient has received no previous digitalis. If digitalization fails, quinidine sulfate should be used, as described, to revert the rhythm. Carotid sinus pressure is hazardous in patients with recent myocardial infarction and should be avoided unless deemed absolutely essential.

Atrial flutter is not so common as atrial fibrillation but is treated similarly. In general, one should be content with a controlled ventricular rate produced by digitalis, since flutter is sometimes more difficult to revert to normal. It should be recalled that atropine may increase the ventricular rate in patients with atrial fibrillation, and it is especially likely to do so when there is atrial flutter with a varying atrioventricular block. Accordingly, this drug, as well as meperidine, must be used cautiously when such rhythms are present.

Nodal rhythm, a downward displacement of the cardiac pacemaker, may occasionally develop. Normal sinus rhythm may be restored with atropine sulfate 0.5–1.0 mg. intravenously. When there is slow nodal rhythm with ventricular ectopic beats, the treatment for the ectopic beats may be atropine.

Ventricular tachycardia is a dangerous complication of myo-

cardial infarction, and treatment for this rhythm disturbance is always relatively urgent. The drug of choice is procaine amide. One gram of this drug should be diluted in 250 ml. of 5% dextrose in water and given slowly intravenously. An electrocardiograph should remain attached to the patient to obtain short rhythm strips at frequent intervals. Additional procaine amide may occasionally be needed. When the QRS complex widens significantly, the danger of the rhythm must be judged against the danger of the therapy. When the rhythm reverts, the intravenous drip of procaine amide should be discontinued. When hypotension develops due to procaine amide, levarterenol may be used. Some physicians prefer the oral or intramuscular route of administration of procaine amide. Actually, the intravenous route, if used properly, with blood pressure and electrocardiographic monitoring, may be the safer route to employ, since it avoids the uncertainty of intramuscular or gastrointestinal pick-up. In addition, a toxic build-up of the drug is less likely to occur following the reversion of the rhythm. Although procaine amide is the drug of choice, quinidine sulfate may be used if procaine amide fails. Quinidine sulfate, 0.4 Gm., may be given orally every 2 hours for five doses. The electrocardiogram should be studied frequently for evidence of toxic effects on conduction. If the oral route is not possible, quinidine gluconate may be given intramuscularly in the dosage of 0.2–0.4 Gm. every 2 hours for four or five doses. With fear and trepidation, 0.8 Gm. quinidine gluconate may be diluted in 500 ml. of 5% dextrose in water and given slowly intravenously when all else has failed. When the rhythm has been reverted to normal after any of these measures, 0.5 Gm. of procaine amide or 0.4 Gm. of quinidine sulfate may be given every 6 hours by mouth in order to prevent a recurrence of ventricular tachycardia.

Atrioventricular block, including a long P–R interval, Wenckebach phenomenon and complete heart block, may develop after myocardial infarction. Atrioventricular block is more likely to occur with inferior and posterior infarctions. Fortunately, it is usually transient under these circumstances. First-degree heart block requires no therapy. Second-degree block and complete heart block must be viewed with some concern. Under such circumstances, an external cardiac pacemaker should be attached to the patient in anticipation that cardiac standstill may occur (29). Atropine sulfate in the dose of 0.5–1.0 mg. should be given intramuscularly every 4–6 hours. If atropine fails or if it is not tolerated well, 5–10 mg. isopropylarterenol (Isuprel) may be

given sublingually every 2–4 hours. When syncope occurs as a complication of heart block (Stokes-Adams attack), the cardiac mechanism may be either ventricular standstill or ventricular fibrillation. When the episodes of syncope are related to proved ventricular standstill, an external pacemaker may be set to stimulate the heart whenever the episode of standstill lasts over a few seconds. When the episodes of ventricular standstill occur frequently in a patient with complete heart block, it may be necessary to use measures to increase the idioventricular rate. This can be done by the slow intravenous drip of isopropylarterenol, 1 mg. in 250 ml. of 5% dextrose in water, or of epinephrine, 4 ml. of 1:1,000 solution in 1 L. of 5% dextrose in water. It is not uncommon to be periodically stimulating the heart with the pacemaker while administering isopropylarterenol by slow intravenous drip. Under such circumstances, the external cardiac stimulation may usually be gradually eliminated, while intravenous isopropylarterenol may be discontinued when the sublingual route proves adequate. Occasionally, the external cardiac pacemaker may be needed for several days; rarely, it may be needed for 2 or 3 weeks or even longer. Several cases with syncope related to heart block that had been refractory to all routine therapy are now on record in which small electrodes were attached to the heart and the ventricle stimulated by a small battery-powered portable pacemaker fastened to the surface of the chest. Fortunately, the necessity for this procedure is relatively rare.

When ventricular tachycardia or ventricular fibrillation interrupt complete heart block, the treatment is not nearly so satisfactory. Usually, quinidine sulfate and procaine amide are contraindicated in this situation. At times, the ventricular fibrillation or tachycardia has seemingly been the result of excessive slowing of the basic idioventricular pacemaker. Measures that are useful in increasing the rate of the basic ventricular pacemaker, as described above, may prevent subsequent episodes of ventricular tachycardia or ventricular fibrillation. The use of external countershock as therapy for ventricular fibrillation has not had widespread use, but several cases are on record where this form of therapy has been successful.

When the circulation becomes inefficient, presumably due to cardiac standstill or fibrillation, as in a person at a sports event, it is not considered advisable, as a general rule, to open the chest to reinstitute cardiac action. A forceful blow to the anterior precordium with a closed fist, plus elevating the legs of the unfortunate subject, may be all the treatment that can be given. Un-

fortunately, a physician is not able to perform both cardiac resuscitation and respiratory resuscitation, both of which are necessary in order to get oxygenated blood to the brain within the 3-minute time limit.

If a patient is in an area of a hospital, such as the Emergency Clinic, where additional personnel and the proper equipment is available, including the necessary equipment for respiratory resuscitation, it may be proper to open the chest of a patient who has a cardiac arrhythmia resulting from acute myocardial infarction. If the patient is already in shock, due to massive cardiac destruction, or if he has a history of long-standing heart failure and has had multiple myocardial infarctions, the chance of resuscitation will be small and therefore is seldom attempted. On the other hand, if the patient's blood pressure is normal, he has had no heart failure, he is a relatively young person who has not had massive cardiac destruction but has simply had a cardiac arrhythmia, then successful cardiac resuscitation might be possible. How many such individuals have been resuscitated under such circumstances is not known. If the cardiac pacemaker is readily available and can be applied within 30 seconds, this should, of course, be tried first. The simplest procedure of all—a firm blow to the anterior precordium—should never be forgotten, and there are many cases on record of successful resuscitation by the use of this measure.

Congestive Heart Failure

Patients with coronary atherosclerosis may develop heart failule secondary to a loss of functioning myocardial tissue and its replacement by fibrous tissue. As stated earlier, such patients usually have a history of angina pectoris or myocardial infarction or have electrocardiographic or roentgenologic clues to the diagnosis. In an occasional patient, heart failure may develop without any clues to the diagnosis of coronary artery disease. However, whenever heart disease is diagnosed by the mere presence of heart failure, there are numerous other etiologic possibilities. Accordingly, one should make the diagnosis of a coronary atherosclerotic origin with considerable caution under such circumstances.

The basic treatment of chronic congestive heart failure is not altered when the cause is coronary atherosclerosis. It should be noted that the most commonly overlooked sign of left ventricular failure is the development of an S_3 gallop. When this or other

manifestations of congestive failure are present, treatment includes digitalis, diuretic agents, restricted activity and restricted sodium intake. The dosage of digitalis cannot be predicted; it must be guided by therapeutic or toxic effects. One cannot judge proper dosage by body weight or from the electrocardiogram. In certain situations, particularly with hypokalemia, cor pulmonale or in elderly, debilitated patients, there occasionally is an apparent increased sensitivity to digitalis preparations.

Pulmonary edema may follow acute myocardial infarction. Therapy here, as with pulmonary edema due to other causes, includes morphine, tourniquets, orthopneic position, oxygen and digitalis. Occasionally, the morphine may be given slowly and cautiously by vein with considerable benefit. Aminophylline is frequently given intravenously for pulmonary edema. Since it may greatly increase cardiac work, this drug should be used with great caution in the presence of acute myocardial infarction.

At times, congestive failure following an acute infarction will be manifest by hepatomegaly, distended neck veins, pulmonary rales and tachycardia. The significance of the development of an S_3 gallop as a manifestation of ventricular failure must constantly be kept in mind. It may be the earliest manifestation of failure following an acute infarction. When the S_3 gallop or other evidence of ventricular failure is present, digitalis, sodium restriction and perhaps diuretics are indicated. Too often, digitalis is withheld from the patient with myocardial infarction when it should be given. In general, there has been too much concern, and even horror, expressed about the dangers of the use of digitalis for ventricular failure following acute myocardial infarction.

Some patients who have required digitalis for ventricular failure after a myocardial infarction will need it for the rest of their lives; some will not. Generally, digitalis, once started, should not be discontinued until the patient has returned to work and has tolerated the extra load without difficulty. In such circumstances, if there is no evidence of ventricular failure or dilatation, the physician may cautiously withdraw the drug.

Thrombophlebitis and Pulmonary Emboli

Patients with myocardial infarction frequently die of acute pulmonary embolism. Repeated pulmonary emboli often simulate myocardial infarction and may precipitate and aggravate congestive heart failure. Anticoagulant therapy decreases the

incidence of pulmonary embolism. Pulmonary emboli following a myocardial infarction come from endocardial mural thrombi and from the pelvic or leg veins, the majority of emboli originating in the leg veins. Most of the venous thromboses resulting in pulmonary emboli occur without objective evidence of venous disease. All of the factors leading to the high incidence of pulmonary emboli after myocardial infarction are not known, but it has been suggested that there are changes in the clotting system and the vascular endothelium in addition to slowed circulation and venous stasis.

Since pulmonary emboli are common, every effort should be made to prevent them. In addition to anticoagulants, it is desirable to have the patient flex the feet and ankles for a few minutes several times each day. It is important that no areas of pressure occur in the calves or behind the knees, especially when sitting in the lounge chair or in the bed. If elastic stockings are used, they must be carefully fitted, both to be effective and to avoid compression at the upper level.

If acute pulmonary embolism does occur, the treatment is supportive, including oxygen, morphine, vasopressor agents and occasionally atropine. Some feel that heparin may be of more value than oral anticoagulation when definite thrombophlebitis or pulmonary embolus is present. If pulmonary embolism occurs in a patient already adequately anticoagulated, surgical interruption of venous return must be considered. If this catastrophe has occurred shortly after myocardial infarction, it is obvious that considerable judgment will be required to determine whether the risk of surgery is greater or less than the risk of additional emboli. It is technically possible to remove large emboli lodged in the pulmonary arteries; however, because of the risk of such a procedure following myocardial infarction, one's enthusiasm for the procedure is considerably decreased. The value of fibrinolytic agents in the treatment of thrombophlebitis and pulmonary emboli is controversial.

Peripheral Emboli

Peripheral emboli from a mural thrombus following a myocardial infarction have occurred with less frequency during the anticoagulant era. Since they still occur, it is valuable to have a record made of the strength of pulsations of the abdominal aorta and the femoral, popliteal, dorsalis pedis and posterior tibial vessels in all patients. This is of tremendous value, especially

when one has to decide whether or not an arterial embolism is present, particularly since pain often is not present or may disappear as the nerves themselves become ischemic. Too often, the complaint of a limb "going to sleep" has been passed off as benign without the realization that the condition was secondary to arterial embolism.

Except for cerebral emboli, immediate intravenous heparin therapy is indicated for peripheral emboli, especially when there is some delay in obtaining a surgical consultation. If surgery is advised, the effect of heparin can be readily reversed with protamine.

A saddle embolus at the aortic bifurcation demands immediate embolectomy, as do most emboli in the iliac or femoral arteries. Accordingly, it may be necessary to subject patients to vascular surgery several days after myocardial infarction. The risk is great, but often there is no other choice. Emboli in the arms and distal leg vessels usually do not require surgery, but this must be individualized. The use of sympathetic block, including stellate ganglion block for cerebral embolus, must also be individualized. In the anticoagulated patient, even sympathetic block should not be done.

Emboli in the spleen and kidney do not usually require specific therapy other than anticoagulants to prevent further emboli. It is possible that some episodes of unexplained abdominal discomfort after a myocardial infarction may be due to small mesenteric emboli. On rare occasions, massive gangrene of the bowel may occur.

Postmyocardial Infarction Syndrome

Dressler first popularized this syndrome (8). It is amazing that this condition was not described earlier, since it is said to occur following 3–4% of acute myocardial infarctions. We believe that there is such a syndrome but that it is quite rare.

Postmyocardial infarction syndrome consists of prolonged and recurrent episodes of fever and pleuropericardial pain, recurrent or persistant precordial friction rub and oftentimes hemorrhagic pericardial or pleural effusions and pneumonitis. Leukocytosis and elevation of the sedimentation rate are present in most cases. The etiology of the syndrome is unknown, but it has been suggested that it represents a hypersensitivity reaction to autoantigens produced by the necrosis or myocardial tissue. Its major

significance lies in the importance of differentiating it from recurrence of myocardial infarction, from pneumonia or from pericardial hemorrhage due to excessive anticoagulation. One of the greatest problems is to differentiate this syndrome from repeated pulmonary emboli. Once recognized, it is best to stop anticoagulants and to treat the pain with codeine. If these fail, cautious therapy with corticosteroids, in dosages as small as possible to control symptoms, may be employed. Such therapy may be required for many weeks, or even months, before the patient can be successfully weaned from it. Occasionally, the syndrome may recur repeatedly following a single infarction.

Ventricular Aneurysm

There are two types of ventricular aneurysm related to myocardial infarction. One type is a systolic bulging of the ventricular wall which may produce a palpable pulsation on the anterior chest. This type of aneurysm requires pressure for the bulging to occur, and no bulge is usually found at autopsy. The other type is a true anatomic aneurysm of the ventricular wall; this type may be seen at autopsy. The clinical diagnosis of both types depends on the following: (1) finding a precordial systolic bulge and a persistence of S–T segment elevation in precordial leads after the evolvement of the electrocardiographic picture of myocardial infarction and (2) roentgenologic and fluoroscopic examination.

Healed aneurysms rarely rupture, but they may have mural thrombi which may cause subsequent peripheral emboli. There is evidence that the development of a large ventricular aneurysm may significantly interfere with myocardial hemodynamics. The presence of the noncontractile but expansile sac can be expected to interfere with normal left ventricular ejection.

Surgical excision of the aneurysm has been successfully accomplished, apparently for symptoms of congestive failure (5). Adequate follow-up studies are not available for the evaluation of any benefits.

Antithyroid Medication

Since thyrotoxicosis aggravates angina pectoris, it was logical to attempt to relieve angina pectoris in euthyroid patients by

depressing the activity of the thyroid gland. This was first done by the surgical removal of the thyroid gland, but this approach has given way to medical measures designed to produce the same effect (2). The benefit derived by producing hypometabolism in patients with angina pectoris is thought to be due to a decrease in the oxygen demand by the tissues and a decrease in the sensitivity of the tissues to epinephrine.

Antithyroid therapy should be used in incapacitated patients with moderately severe but nonprogessive angina pectoris. Such therapy should not be used until enough time has elapsed to convince the physician that the angina is not decreasing. Anxious patients who are hyperreactors to stress seem to be the best candidates for this form of therapy. All of the usual therapy should have been tried before considering the use of antithyroid drugs. The level of protein-bound iodine should be determined before using antithyroid measures. If this level is low, antithyroid medication should not be used.

Some benefit can occasionally be obtained by the use of propylthiouracil or methimazole. Because of this, and since their effects are reversible, these drugs are sometimes used prior to the use of I^{131}.

Iodine-131 may be given orally in a single dose of 20 mc. or in three divided doses of 10 mc. at weekly intervals.

Symptoms of myxedema may develop after I^{131} therapy. The weakness, tearing of the eyes, peripheral neuropathy and sensitivity to cold may be quite distressing. Small amounts of desiccated thyroid may be required to relieve these symptoms.

This form of therapy is used only when things are not going well. Accordingly, it is hard to judge its benefit. Some patients seem to have less pain and are rehabilitated following I^{131} therapy (4). Many patients, however, have not acclaimed this treatment with much enthusiasm.

Tobacco

There are no good clinical studies on the relationship between cardiovascular disease and chewing tobacco or dipping snuff. There are data, however, suggesting that there is a higher incidence of coronary atherosclerosis in cigarette smokers than in nonsmokers (13).

An occasional patient will have angina pectoris precipitated by smoking. This patient should stop smoking, if possible.

If the patient is a lifelong habitue of the tobacco weed, he is not easily weaned from the habit. Advice on smoking must be tempered with the realization that the effects of sudden complete stoppage of smoking may be worse than the effects of a few cigarettes per day.

Surgical Approaches to Treatment of Coronary Atherosclerosis

None of the various surgical procedures (18) used in the treatment of coronary atherosclerosis have, as yet, stood the test of time. The operations used in ischemic heart disease are of two types: some are designed to decrease pain by interrupting the sensory nerve fibers of the heart, while others are designed to increase the blood supply to the heart. Some procedures are said to accomplish both of these feats. These procedures include: posterior rhizotomy; cervicothoracic ganglionectomy; pericoronary neurectomy; installation of foreign substances, such as talc, asbestos and bone dust into the pericardial space; de-epicardialization with phenol; partial ligation of the coronary sinus; cardiomentopexy; the suturing of lung, pectoral muscle and jejunum to the epicardium; arterialization of the coronary sinus; resection of the occluded coronary artery; coronary endarterectomy; and transplantation of an artery into the myocardium.

After all other forms of therapy have failed, one of the above procedures may be used for an occasional patient with disabling angina pectoris. No definite promise of relief can be given the patient, but some patients will have a significant decrease in symptoms following surgery. The procedures are still investigational, and the particular operation used will depend, to some degree, on the research activity of the surgeon selected.

Until the etiology of obstructive coronary disease is understood and preventive measures have proved successful, it is entirely proper and desirable for surgeons of vision to continue their work in this field.

Diet

It has been shown that people with normal body weight live longer than those who are obese. Accordingly, the maintenance of normal body weight seems to be a good general health meas-

ure. There is uncertainty regarding the relationship between obesity and the development of atherosclerosis, although several studies have suggested that atherosclerosis is many times more common in obese subjects than in lean (26, 9).

Fat people with angina pectoris may have less angina when they reduce. Here the extra poundage has produced a chronic increase in cardiac work, such as carrying a 50-lb. sack of butter on one's back. When angina pectoris seems to be directly related to eating a large meal, it is valuable to allow several small meals. Here the postprandial angina pectoris is due to an acute increase in cardiac output and work.

The work of chewing and digestion increase the burden on the heart. Accordingly, the patient who has just experienced a myocardial infarction should not be given food or fluid during the first few hours except small sips of water as desired. For the first few days the diet should be liquid or soft, depending on the severity of the attack. This is followed by a regular diet with calories adjusted to obtain gradual weight reduction if this is desirable. It is not necessary to restrict sodium intake as a routine measure in patients who have had a myocardial infarction. This should be done only when there is ventricular failure or when such failure is highly likely to occur. Iced drinks—particularly the bedside carafe of iced fluids—should be avoided. Cold may precipitate myocardial ischemia.

People living in countries where the average fat intake is high are said to have a high incidence of coronary athersclerosis, and people living in countries where less fat is consumed are said to have a low incidence (15, 16). Many observers have pointed out that in each particular country there are factors other than fat intake which may influence the atherosclerotic process (20, 28). At present, the available data do not allow one to have a rigid view regarding the relationship of diet to coronary atherosclerosis. At the same time, the data do suggest that a diet for a normal person and for those with recognizable coronary atherosclerosis should be one which avoids or corrects obesity and one in which the fat intake is moderately low. As will be noted below, in the section on harmful drugs, diets and procedures, many a patient has been made miserable because of rigid views regarding diet. The unsaturated fatty acids, sitosterol and other substances may alter the blood lipids in a favorable manner, but it has not been proved whether they alter the atherosclerosis process in human beings.

The lack of definite answers regarding diet and its relationship to atherosclerosis is admittedly frustrating. On the other hand, to accept all of the ideas as the final truth could possibly retard a clearer understanding of the atherosclerotic process.

Harmful Drugs, Diet and Procedures

A number of drugs can precipitate cardiac ischemia in patients with coronary atherosclerosis. Some drugs, such as hexamethonium, may produce hypotension and cause cardiac ischemia; pitressin may produce severe cardiac ischemia. It is not rare to have chest pain develop in a hypertensive patient following the Regitine test. Epinephrine must be used with great caution in patients with coronary atherosclerosis. A rapid fall in blood sugar, secondary to insulin, even without hypoglycemia, may cause cardiac ischemia, probably by simulating epinephrine release. Large amounts of thyroid extracts may produce hypermetabolism and increase the symptoms of coronary disease. Antabuse may lower pressure and decrease coronary artery perfusion. Rauwolfia serpentina may cause nightmares and produce noctural angina.

The infliction of new diets on all patients without regard to the emotional turmoil they can sometimes cause may lead to harm. Too often, patients are told that "eggs, bacon, milk and butter and anything made from these substances are bad for your heart." If a 50-year-old patient who is set in his dietary habits enjoys these foods, he may find that he cannot change his habits; and when he eats the foods considered so poisonous, he then anticipates another heart attack. The diet, especially diets of unproved value, might be prescribed on an individual basis, taking into account the personality of the patient. Beware of the situation in which the patient adheres too closely to an extremely rigid diet, for he is frequently undergoing an emotional upheaval.

Be wary of checking the serum cholesterol too often. Many physicians and their patients become obsessed with the cholesterol level and have it checked every few weeks. The patients are happy when the cholesterol is low and depressed when it is elevated. Such an attitude cannot be supported by any scientific facts now available.

On theoretical grounds, a sudden marked weight loss by starvation diets may be harmful. In extreme cases this would

be similar to a high-fat diet. A carefully controlled study to determine the incidence of myocardial infarction in patients who have undergone recent marked weight loss would be of considerable interest.

Too many electrocardiograms can be recorded. The patient may be quite disturbed when he learns that there has been "no change." Accordingly, it is necessary to teach the patient that certain changes in the electrocardiogram may persist forever. Whenever an electrocardiogram is obtained and interpreted without obtaining a detailed history from the patient, an error may be made.

The change or lack of change of the serum enzymes may be misinterpreted. Patients may have prolonged pain that is obviously due to cardiac ischemia, and this may be disregarded when the serum transaminase remains normal. This indicates a lack of concept. In the coronary arteries that require therapy, much can happen which may not cause an elevation of serum transaminase. The transaminase becomes abnormally elevated only when a sufficient number of cells die and liberate the enzyme.

Some patients who are experiencing the pain of angina pectoris and myocardial infarction have less pain while sitting up. Too many of the hospital personnel have been taught to force a man to lie flat in bed. They should be taught that an occasional patient obtains relief by sitting up. The harmful effects of balancing on a bedpan in order to have a bowel movement or to urinate have been stressed earlier.

Vigorous diuresis and other dehydrating procedures may cause considerable hemoconcentration. This may precipitate thrombosis in the coronary arteries or in the cerebral vessels. If a patient with polycythemia has severe heart failure and has accumulated a large amount of extracellular fluid, it is probably wise to perform small phlebotomies sufficient to maintain a normal hematocrit during the period of diuresis.

It is desirable to record the blood pressure several times a day during the first day or so after a myocardial infarction. It is not necessary to do so, in the average case, throughout the hospital stay. This procedure can worry patients.

The rectal examination should usually be delayed for several weeks after a myocardial infarction, although fecal impaction can be more dangerous than a rectal examination.

CURRENT RESEARCH IN CORONARY ATHEROSCLEROSIS

At present, exciting studies (12) pertaining to coronary atherosclerosis are being done in regard to: its actual incidence in various groups; clinicopathology; genetic factors; anatomy of the coronary tree; body build, including obesity; sex and exogenous estrogens; exercise and lack of exercise; stress; way of life; occupation; lipid and cholesterol metabolism, including lipid clearing factors; nutrition, including the effects of low-cholesterol, low-fat, low-carbohydrate, low-protein, and low-caloric diets and the effects of nicotinic and ascorbic acids, pyridoxine, tocopherol; various "essential" or unsaturated fatty acids, and animal versus vegetable fats; mechanisms of blood clotting and fibrinolysis; the influence of hypertension, diabetes and related diseases, vascular surgery; and aids to the clinical recognition of the disease.

The blank verse at the beginning of this monograph was meant to illustrate the dilemma facing the patient and the physician in regard to coronary atherosclerosis. This dilemma exists because there are still but few definite answers to the many problems of etiology, prevention and reversibility of this disease. It now seems most likely that the ultimate answers will come from the biochemical research laboratories.

SUMMARY

1. Whenever there are symptoms or signs indicating that the coronary obliterative process has developed more rapidly than the collateral circulation, it is highly probable that a small or large myocardial infarction has occurred. In addition to the so-called "classic myocardial infarction," it is likely that the onset of angina pectoris, angina pectoris that is worsening and pain of coronary origin of more than 30 minutes' duration—all represent myocardial infarction.

2. The maintenance of an optimistic attitude, efforts toward sensible rehabilitation, and prompt recognition and treatment of the many possible complications—all serve to decrease the morbidity and mortality of this disease. Although not spectacular, these points have been emphasized while we await the more dramatic results which may come from investigational efforts.

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